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ANNUAL REPORT

OF THE

INSPECTOR

OF

Gas Meters and Illuminating Gas.

JANUARY, 1898.

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Commonwealth of Massachusetts.

OFFICE OF INSPECTOR OF GAS AND GAS METERS,
32 HAWLEY STREET, BOSTON, MASS., Jan. 31, 1898.

Hon. WM. M. OLIN, *Secretary of the Commonwealth.*

SIR: — I have the honor to hand you herewith the report of the Inspector of Gas Meters and of Illuminating Gas for 1897.

Respectfully,

CHAS. D. JENKINS.

REPORT.

OFFICE OF GAS INSPECTION, 32 HAWLEY STREET,
BOSTON, MASS., Jan. 29, 1898.

To the Honorable Senate and the House of Representatives.

The Inspector of Gas Meters and of Illuminating Gas submits the following report: —

During the year ending Dec. 31, 1897, 645 gas inspections were made, 23,127 gas meters tested and several analyses and calorimetric tests made, besides the regular office work.

Of the meters tested, 22,684 were either new or repaired, and were presented by the manufacturers or gas companies for inspection; a few of these meters, failing to meet the requirements, were returned for adjustment, and then retested before being finally sealed. In order to pass inspection, meters must register accurately, within two per cent., fast or slow, the amount of gas delivered by the standard measure at the legal rate of six feet per hour for each light the meter is marked to supply, especial attention being paid to the temperatures. Meters passing inspection bear, soldered on the left-hand front corner of the top, a brass badge with the inspector's serial number, and on the diagonally opposite corner the date impressed in sealing wax.

A number of so-called "prepayment" meters were tested. A prepayment meter is one having an attachment by which, through the use of a coin, a stop is set to shut off the supply after an amount of gas equal to the value of the coin has passed through the meter. No distinction has been made in testing these meters, as the attachment is a device to aid in the settlement of the bill, and not to the measurement of the gas; the exact standing of the consumer's account is deter-

mined by the register of the regular dials, as in the usual form of meter. The object of this form of meter is to make the "prepayment" for gas to be used necessary to the supply of same. It may also increase the consumer's acquaintance with a gas meter, — a much-to-be-desired relation; from being obliged to visit the meter once or twice a week, to insert a quarter or other coin, the consumer may begin to read the meter, and thus notice the amount of gas consumed from day to day or week to week.

It is not a difficult matter to read a meter. On the dial are three or more circles, each divided into ten parts, with a hand for each circle; to read, one must begin at the left and read the smaller figures or the figures the hands have passed; but for the extreme right-hand circle, the figure which the hand is nearer is read. These figures, after adding two ciphers, give the present "state" of the meter; after subtracting the previous reading, or state, the result is the number of cubic feet consumed. It is very similar to getting the length of time that has elapsed between two readings of a clock; *e.g.*, between 10.15, the previous "state," and 11.40, the present "state," one hour and twenty-five minutes have been "consumed." One complete revolution of the hand of the extreme right circle shows one thousand feet, and therefore each division shows a tenth, or one hundred feet; for this reason, two ciphers are added to the reading. The hand of the circle next to the thousand feet circle registers ten thousand feet for a revolution; that is, one division for each complete revolution of the thousand feet circle hand. Care must be taken that the thousand feet hand has completed the revolution which the figure read on the ten thousand feet circle records; that is, if the ten thousand feet hand is nearly or quite on the 3, one must be sure that the thousand feet hand is up to or beyond the 0; if it is only just by the 9, the reading would be 2, 9 and not 3, 0. The rule applies as well to the other circles.

In accordance with the provisions of section 12, chapter 61, Public Statutes, 443 meters were re-tested last year. This section provides for the re-inspection by this office of a meter in use, on the complaint of the consumer or gas

company. Nine of these meters would not register; 220 were correct within the legal limits of 2 per cent., either fast or slow; 183 were fast, that is, registered more gas than was passed, the average error being 4.98 per cent.; 31 were slow, the average error being 12.39 per cent., — the total average error of the 434 registering meters being 1.36 per cent. fast. Of the fast meters, 91 were less than 5 per cent. fast, 83 were between 5 and 10 per cent., 6 between 10 and 15 and 3 between 15 and 20 per cent. fast. Nine meters were less than 5 per cent. slow, 11 were between 5 and 10 per cent., 5 between 10 and 15 per cent., 2 between 15 and 20 and one each 20, 28, 30 and 122 per cent. slow. The facts relate to the register of meters; a meter may be 122 per cent. slow, if it passes 2.22 feet while registering but 1 foot. A comparison with previous years, of this class of meters, is given in the following table: —

YEAR.	Fast Meters.		Slow Meters.		Correct.	Total.	
	Number.	Per Cent.	Number.	Per Cent.	Meters.	Number.	Per Cent.
1890,	64	5.32	20	23.60	134	218	0.60 slow.
1891,	52	4.74	34	10.03	144	230	0.41 slow.
1892,	105	5.67	49	9.28	190	344	0.41 fast.
1893,	197	5.10	46	9.30	284	527	1.23 fast.
1894,	217	4.70	55	8.56	327	604	0.99 fast.
1895,	301	4.73	93	9.72	549	957	0.40 fast.
1896,	477	4.87	113	8.41	602	1,200	1.22 fast.
1897,	183	4.98	31	12.39	220	443	1.36 fast.

The gas supplied by the 68 companies was tested at irregular intervals during the year, no notice whatever being given of an intended visit. The law provides two inspections of each company yearly, with an additional inspection for each six million feet of gas supplied, until the inspections become weekly. The candle-power must not be below sixteen, and

there must not be more than twenty grains of sulphur or ten grains of ammonia per one hundred feet of gas, or any sulphuretted hydrogen.

The candle-power is taken by the Bunsen disc photometer, using the English sperm candle, made for this purpose, as a standard. The burner best adapted for the gas, and at the same time suitable for domestic use, while burning at the rate of five feet of gas per hour, is the burner used. For coal gas, mixed coal and water gases and low candle-power water gas, the improved Sugg's London argand, size F, has been found most suitable; for water gas, the Sugg's table top lava tip, six feet size, is the one used. The old pattern Sugg's argand D, as well as the improved D, is used for low candle-power coal gases. For the oil gases, open burners, ranging from one-half foot to three feet capacity, are used. All candle-powers are given corrected to the legal rates of burning, five feet of gas and one hundred and twenty grains of sperm per hour.

The ammonia is determined by bubbling the gas through hydrochloric acid of known strength; and the sulphur is determined by burning the gas in an atmosphere containing ammonia, the resulting ammonic sulphate, held in solution by the condensed water, being analyzed.

Sulphuretted hydrogen, easily detected by exposing paper, moistened with basic plumbic acetate, to a stream of the gas, is an impurity which ought to be taken out completely, and its presence indicates carelessness or imperfect apparatus.

In the following tables are given the averages of the inspections of the gas of each company. These results are furnished the Board of Gas and Electric Light Commissioners from time to time during the year, at its request.

Larger Companies.

Number of inspections made.	NAME OF PLACE OR COMPANY.	CANDLE-POWER.			GRAINS PER ONE HUNDRED FEET OF GAS OF —	
		Average.	Highest.	Lowest.	Sulphur.	Ammonia.
52	Boston, . .	25.26	27.2	22.2	8.18	1.—
6	Brockton, . .	18.02	21.0	15.6	13.05	6.13
52	Brookline, . .	25.47	27.2	23.9	7.78	1.—
32	Cambridge, . .	17.81	19.4	16.3	11.57	1.—
19	Charlestown, .	19.32	21.2	18.4	12.85	1.—
7	Chelsea, . .	18.06	18.9	17.4	11.40	1.81
28	Dorchester, . .	25.55	27.6	22.8	8.50	1.—
10	East Boston, .	18.92	20.1	18.2	9.54	2.25
15	Fall River, . .	23.98	26.1	21.7	7.91	1.—
5	Fitchburg, . .	18.36	21.8	16.4	10.74	1.02
6	Gloucester, . .	18.32	19.2	16.8	12.65	1.—
14	Haverhill, . .	24.51	26.7	22.0	7.48	1.—
12	Holyoke, . .	19.19	20.8	17.3	9.29	3.78
12	Jamaica Plain, .	17.47	18.9	15.1	9.22	8.15
15	Lawrence, . .	19.68	20.9	18.8	9.39	1.—
50	Lowell, . .	20.50	22.1	18.5	10.48	2.06
22	Lynn, . . .	20.09	22.2	17.8	12.33	1.—
11	Malden, . .	19.00	19.7	18.2	14.77	1.—
11	New Bedford, .	20.29	21.4	19.6	8.13	1.—
16	Newton, . .	18.49	20.1	17.2	12.19	1.—
5	Northampton, .	19.40	20.4	18.7	7.80	2.62
5	North Adams, .	17.94	18.3	17.3	8.78	6.42
5	Pittsfield, . .	25.82	31.2	22.7	5.40	1.—
38	Roxbury, . .	25.27	27.8	23.3	7.71	1.—
9	Salem, . . .	17.90	18.9	16.9	13.36	2.51
19	South Boston, .	25.62	26.7	24.4	8.18	1.—
19	Springfield, .	19.44	21.6	17.5	11.28	1.—
9	Taunton, . .	18.08	20.3	16.4	10.94	2.08
6	Waltham, . .	17.35	18.8	15.7	6.83	4.37
34	Worcester, . .	20.65	23.3	18.6	11.25	1.—
	Average, .	20.53	–	–	9.97	1.92

Smaller Companies.

Number of Inspections made.	NAME OF PLACE OR COMPANY.	Candle-power.	Grains per One Hundred Feet of Gas of—	
			Sulphur.	Ammonia.
2	Adams,	23.40	8.25	1.—
3	Amesbury,	20.77	12.67	1.—
3	Arlington,	17.93	7.03	3.27
3	Athol,	21.57	5.47	1.—
3	Attleborough,	16.83	8.83	1.—
3	Beverly,	17.77	10.33	8.93
3	Chicopee,	23.10	7.87	1.—
3	Clinton,	16.13	7.87	2.23
2	Danvers,	18.30	13.25	1.—
3	Dedham,	17.77	9.80	3.17
2	Easthampton,	19.25	10.15	9.10
3	Greenfield,	18.30	12.40	10.37
2	Ipswich,	24.40	4.20	1.—
2	Marblehead,	16.95	14.70	1.—
3	Marlborough,	16.97	12.03	1.—
4	Milford,	17.65	8.05	3.62
2	Nantucket,	17.65	6.30	2.25
3	Natick,	16.60	11.87	1.—
4	Newburyport,	18.27	9.12	1.—
3	Norwood,	17.17	9.10	2.57
3	North Attleborough,	17.27	10.33	1.—
3	Plymouth,	17.93	9.70	15.80
3	Quincy,	18.77	12.45	3.07
2	Southbridge,	21.45	6.00	1.—
3	Spencer,	21.83	5.67	1.—
3	Stoneham,	20.67	3.43	1.—
3	Wakefield,	18.93	11.73	1.—
2	Ware,	18.05	9.35	2.65
2	Webster,	17.60	8.80	1.—
4	Westfield,	18.95	5.67	1.—
3	Woburn,	18.07	10.80	1.—
	Average,	18.91	9.13	2.65

Companies making Gas from Petroleum.

Number of Inspections made.	NAME OF PLACE OR COMPANY.	Candle-power.
2	Amherst,	35.50
2	Gardner,	48.20
2	Leominster,	30.45
2	Lexington,	30.05
2	Middleborough,	26.60
2	Stoughton,	48.25
2	Williamstown,	47.70
	Average,	38.11

The following table gives some interesting comparisons with former years: —

	1897.	1896.	1895.	1894.
All companies but oil gas: —				
Average candle-power,	19.71	19.07	19.30	19.31
Average sulphur, grains per 100 feet,	9.54	8.85	9.29	9.47
Average ammonia, grains per 100 feet,	2.29	1.79	2.46	2.57
Average candle-power: —				
Thirty-six coal gas companies,	17.92	17.61	18.03	17.98
Sixteen water gas companies,	23.66	22.77	23.28	23.64
Nine mixed coal and water gas companies,	19.79	19.39	19.65	19.63
Seven petroleum gas companies,	38.11	35.41	33.00	31.48

At Plymouth, Westfield and Gloucester the tests have been made, as formerly, at the works, as being the most

available places. The Chicopee Falls territory is now supplied by the Chicopee Gas Light Company. The Ipswich company now supplies Kendall gas, one test being of this gas. Southbridge has changed from oil to water gas, the last test being of the new gas.

In the following tables are given the particulars in which the various companies failed to meet the requirements of the law: —

Deficient candle-power: —

Brockton, April 14,	15.7
Brockton, November 20,	15.6
Clinton, September 24,	14.2
Jamaica Plain, November 16,	15.1
Norwood, October 9,	14.8
Waltham, May 27,	15 7

Excess of sulphur (grains per 100 feet): —

Brockton, December 29,	26.4
Malden, December 30,	21.7
Taunton, December 17,	21.1

Excess of ammonia (grains per 100 feet): —

Beverly, August 10,	15.6
Easthampton, March 25,	12.2
Greenfield, May 19,	17.3
Jamaica Plain, April 17,	22.2
Jamaica Plain, May 15,	27.5
North Adams, May 19,	21.7
Plymouth, June 14,	19.2
Plymouth, October 8,	13.9
Plymouth, December 11,	14.3

Sulphuretted hydrogen present: —

Adams, May 20.
Amesbury, February 9.
Amesbury, October 5.
Amesbury, December 16.
Amherst, December 27.
Arlington, December 18.
Chicopee, March 26.
Fall River, December 2.
Fall River, December 31.
Lexington, October 7.
Middleborough, December 10.
Quincy, December 11.
Southbridge, August 11.
Spencer, May 11.
Spencer, December 23.
Stoneham, March 24.
Stoneham, December 29.

At Brockton the deficient candle-powers were not consecutive.

At Plymouth the three excessive ammonias were consecutive, and a fine became due the town.

The Jamaica Plain ammonias were consecutive, but the next test, June 16, showed but 9.6 grains.

The presence of sulphuretted hydrogen at Adams was for the second consecutive time, but December 8 the gas was clean.

At Amesbury the tests were consecutive, and a fine became due the town.

At Fall River, Spencer and Stoneham, the tests were not consecutive, and at the other places the impurity was detected for the first time.

The following table gives the results of some eudiometric analyses made of various gases, all, excepting the first, being in connection with the calorimetric experiments: —

	Candle-power.	Specific Gravity.	Illuminants.	Marsh Gas.	Hydrogen.	Carbonic Oxide.	Nitrogen.	Oxygen.	Carbonic Acid.
Lowell,	19.8	-	9.84	30.09	39.86	15.70	2.35	-	2.16
Stoughton,	50.8	.870	41.75	47.05	9.76	-	1.44	-	-
Chelsea,	17.1	.390	5.51	35.98	51.03	6.90	0.55	-	0.03
East Boston,	19.2	.414	6.06	36.70	48.10	7.53	1.61	-	-
Lynn,	18.2	.495	8.76	31.60	44.44	12.98	0.62	-	1.60
Woburn,	18.2	.436	7.24	37.49	47.59	7.17	0.51	-	-
Beverly,	18.9	.441	5.97	39.63	46.58	6.19	0.29	-	1.34

Six more gases have been examined with reference to their heating values; in addition to the regular tests for candle-power, sulphur and ammonia, the heat units were determined by Junker's calorimeter, the specific gravity found by the effusion test and the gases analyzed, both eudiometrically and for the relation of carbon and hydrogen in the illuminants, by the Hinman apparatus. Attention was given to temperatures, so that the inlet water and inlet and outlet gas were at the temperature of the room; then the heat measured by the heating of the water came from the combustion of the gas and also from the latent heat in the steam formed by the burning of the hydrogen; this latent heat, made sensible by condensation, was measured and sub-

tracted from the total heat units found, giving "net" units. The British thermal unit is the amount of heat required to raise one pound of water 1° F. In the following table the results are given for one cubic foot of gas measured, saturated with moisture, at 60° F. and 30 inches barometric pressure, this standard being quite near the average conditions under which gas is used. The scientific standard is for dry gas, measured at 32° F. and 29.92 inches; the results obtained under these conditions for coal or water gas will be nearly one hundred heat units higher than the "net" units referred to. As the burnt gases in stoves and engines leave the apparatus, generally, above the boiling point of water, it is misleading to include in the possible available efficiency of a gas the heat obtained by condensing the steam formed.

In the following table the first column gives the total number of heat units obtained from one foot of gas by the Junker's calorimeter. The second column gives the same, as calculated from analysis. The third column gives the "net" experimental heating value of the gas, measured moist, and at 60° F. and 30 inches. In the fourth column are the theoretical values reduced to dry gas, at 32° F. and 29.92 inches, the other standard. The third column only allows for the latent heat; all the others are for the total or "gross" units. The ratio or hydro-carbon density of the illuminants is given in the fifth; this shows the proportion of carbon and hydrogen, and from these figures are calculated the probable heat values of the various illuminants.

	Gross Experimental.	Gross Theoretical.	Net Experimental.	Theoretical at 32° F and 29.92 inches.	Formula for Illuminants.	B. T. U. Illuminants.
Woburn, .	649.3	642.2	596.1	690.7	$C_{2.63}$ $H_{3.53}$	1,410.3
Chelsea, .	618.2	628.4	565.9	675.9	$C_{2.14}$ $H_{4.93}$	1,682.9
East Boston,	655.0	659.0	611.0	708.8	$C_{3.11}$ $H_{4.93}$	2,068.0
Lynn, . .	631.1	640.9	590.7	689.3	$C_{2.46}$ $H_{4.64}$	1,627.0
Beverly, .	691.0	676.7	638.8	727.8	$C_{2.95}$ $H_{5.26}$	2,070.9
Stoughton, .	1,356.0	1,329.0	1,269.0	1,429.0	$C_{2.87}$ $H_{5.91}$	2,143.5

The candle-powers and specific gravities are given in the table of analyses. Woburn was coal gas, enriched with cannel; Chelsea used cannel and oil in moderate proportions; East Boston and Beverly were oil-enriched coal gases; while Stoughton was pure oil gas.

Mr. L. S. James, the assistant inspector, has assisted in the routine work of inspection and also in the experimental work.

Respectfully submitted,

CHARLES D. JENKINS.